AI Opera Generator

Multiple LLMs in Concert 🎭

Let's compose an AI-powered opera! →

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The Premise 🎵

> "They say that all operas are about a soprano who wants to sleep with the tenor, but the baritone won’t let her."

- The wild jungles of Connecticut (post climate change)
- A soprano explorer searching for lost Hartford
- A tenor poet living with the monkeys
- A baritone government agent with a singing robot
- An AI system to write it all…

The AI Orchestra 🎼

- **Text Generation**: GPT-4.1 + Claude Sonnet 4 writing scenes
- **Image Generation**: OpenAI's gpt-image-1 creating illustrations
- **Music Generation**: Suno AI composing arias
- **Voice Narration**: ElevenLabs reading stage directions
- **Audio Content**: NotebookLM discussing the opera
- **Critical Review**: Gemini 2.5 Flash as opera critic
- **All Orchestrated** with Modern Java

```
// Java conducts the AI ensemble
Opera opera = conversation.generateOpera("Hartford Ascending", 5);
OperaImageGenerator.generateImages(opera);
OperaCritic.review(opera);
// Plus: Suno for music, NotebookLM for podcast
```

Lesson 1

Orchestrating Multiple LLMs

The Challenge: AI Collaboration

Traditional approach: One model, one task

```
// Boring! Same voice throughout
ChatLanguageModel model = OpenAiChatModel.builder()
    .apiKey(apiKey)
    .modelName("gpt-4.1")
    .build();
```

Our approach: Multiple models alternating scenes

```
// Exciting! Different perspectives
ChatLanguageModel gpt4 = createGptModel();
ChatLanguageModel claude = createClaudeModel();

// Alternate between them for variety
model = (i % 2 == 0) ? gpt4 : claude;
```

Enter LangChain4j 🔗

The Java Framework for AI Integration

- **Unified API** - Same interface for OpenAI, Anthropic, Google, etc.
- **Memory Management** - Built-in conversation history
- **Modern Java** - Records, virtual threads, functional style
- **Production Ready** - Error handling, retries, timeouts

```
// One interface, multiple models
ChatLanguageModel gpt = OpenAiChatModel.builder()
    .apiKey(apiKey).modelName("gpt-4.1").build();

ChatLanguageModel claude = AnthropicChatModel.builder()
    .apiKey(apiKey).modelName("claude-sonnet-4-20250514").build();

// Same methods, different providers!
String response1 = gpt.generate("Write an opera scene");
String response2 = claude.generate("Continue the story");
```

Setting Up Multiple Models

```
public class AiModels {
    public static ChatLanguageModel getOpenAiModel() {
        return OpenAiChatModel.builder()
            .apiKey(ApiKeys.OPENAI_API_KEY)
            .modelName("gpt-4.1")
            .temperature(0.7)
            .timeout(ofSeconds(60))
            .build();
    }

    public static ChatLanguageModel getAnthropicModel() {
        return AnthropicChatModel.builder()
            .apiKey(ApiKeys.ANTHROPIC_API_KEY)
            .modelName("claude-sonnet-4-20250514")
            .temperature(0.7)
            .build();
    }
}
```

Lesson 2

Managing Shared Memory 🧠

The Memory Challenge

Problem: How do different models maintain context?

- Each API call is stateless
- Models need to know what happened before
- Characters must remain consistent
- Story must flow naturally

Solution: **ChatMemory** from LangChain4j!

Implementing Shared Memory

The Pattern

- Start with premise
- Alternate between models
- Each sees full history
- Memory auto-manages

```
public class Conversation {
    private final ChatMemory memory =
        MessageWindowChatMemory
            .withMaxMessages(20);

    public Opera generateOpera(String title, int scenes) {
        // Add premise
        memory.add(new SystemMessage(PREMISE));

        for (int i = 1; i <= scenes; i++) {
            // Alternate models
            var model = (i % 2 == 1)
                ? AiModels.getOpenAiModel()
                : AiModels.getAnthropicModel();

            // Generate with full context
            var response = model.generate(memory.messages(
            memory.add(response.content());
        }
    }
}
```

Memory in Action

Scene 1 (GPT-4): Sandra meets Lucian

```
SANDRA: Who are you, spirit or man?
LUCIAN: I am Lucian. Here I dwell...
```

Scene 2 (Claude): Government agent appears

```
MAXIMILIAN: Sandra Greaves! Your trespass ends today!
(He remembers Sandra from Scene 1)
```

Scene 3 (GPT-4): Romance develops

```
SANDRA & LUCIAN: (They remember their meeting)
In this green cathedral, love takes root...
```

Lesson 3

AI Comedy Through Absurdity 😄

The Humor Formula

AI models aren't naturally funny, BUT...

Give them an absurd premise → Watch them commit 100%

```
String PREMISE = """
    The wild jungles of Connecticut...
    A tenor poet composing symphonies for monkeys...
    A giant robot that sings Verdi in three languages...
    """;
```

Result: Unintentional comedy gold!

Examples of AI Commitment to Absurdity

The Robot's Aria (Scene 4):

```
ARIA-7 ROBOT (bass, mechanical tremolo):
> VITA È DOLORE! LIFE IS PAIN! LA VIE EST DOULEUR!<br>
> CRUSH THE HEARTS THAT DARE REBEL!<br>
> SCHIACCIARE! DESTROY! ÉCRASER!<br>
> SINGING IS MY PROTOCOL OF HELL!
```

Lucian's Monkey Symphony (Scene 3):

```
LUCIAN: I've taught the howler monkeys Puccini,
        The marmosets know Mozart's every note!
```

Lesson 4

Modern Java + AI 🚀

Java 21 Features in Action

Records for Domain Modeling

```
public record Opera(
    String title,
    String premise,
    List<Scene> scenes
) {
    public record Scene(
        int number,
        String title,
        String content,
        String author
    ) {
        public String getFileName() {
            return String.format("scene_%d_%s.txt",
                number,
                title.toLowerCase().replaceAll("\\W+", "_")
            );
        }
    }
}
```

Virtual Threads for Concurrent APIs

```
public static void generateImages(Opera opera) {
    Semaphore rateLimiter = new Semaphore(2); // Max 2 concurrent

    try (var executor = Executors.newVirtualThreadPerTaskExecutor()) {
        var futures = opera.scenes().stream()
            .map(scene -> CompletableFuture.runAsync(() -> {
                try {
                    rateLimiter.acquire();
                    Thread.sleep(1000); // Rate limiting
                    generateImage(scene);
                } finally {
                    rateLimiter.release();
                }
            }, executor))
            .toList();

        CompletableFuture.allOf(futures.toArray(new CompletableFuture[0])).join();
    }
}
```

✨ Virtual threads = Thousands of concurrent operations with ease!

Pattern Matching & Text Blocks

```
// Pattern matching for response handling
switch (response) {
    case ImageResponse(var url, null) ->
        saveImageFromUrl(url, scene);
    case ImageResponse(null, var b64) ->
        saveImageFromBase64(b64, scene);
    default ->
        throw new RuntimeException("Unexpected response");
}

// Text blocks for prompts
String scenePrompt = """
    Write Scene %d of the opera.

    Remember:
    - %s is searching for Hartford
    - The robot can sing in multiple languages
    - Make it dramatic and slightly absurd
    """.formatted(sceneNumber, soprano);
```

Bonus Lessons

From Development Journey 🎯

API Evolution & Resilience

Problem: OpenAI changed their API (URLs → Base64)

```
// Old DALL-E 3
ImageResponse(String url, String revisedPrompt)

// New gpt-image-1
ImageResponse(String b64Json, null)  // No URL, no prompt!
```

Solution: Adapt quickly, test thoroughly

```
@Test
void exploreGptImageModels() {
    var response = model.generate("A soprano in the jungle");

    assertThat(response.content().url()).isNull();
    assertThat(response.content().base64Data()).isNotNull();
}
```

Rate Limiting Done Right

Problem: Too many concurrent requests = 429 errors

Solution: Semaphore + Virtual Threads

```
Semaphore rateLimiter = new Semaphore(maxConcurrent);

// Elegant rate limiting
rateLimiter.acquire();
try {
    // Make API call
    Thread.sleep(delayBetweenRequests);
} finally {
    rateLimiter.release();
}
```

Benefits:

- No external libraries needed
- Scales with virtual threads
- Easy to tune

Test-Driven AI Development

Challenge: Continue an unfinished opera

```
@Test
void continueHartfordOpera() {
    // 1. Read existing opera context
    String existingStory = readLibretto("hartford_act1.md");

    // 2. Create continuation prompt with context
    String continuation = PREMISE + """
        The story so far: [summary]
        Continue from Scene 6...
        """;

    // 3. Generate remaining scenes
    Opera part2 = conversation.generateOpera(
        "Hartford Ascending", continuation, 3
    );

    // 4. Merge and save complete opera
    mergeOperas(part1, part2);
}
```

Adding Voice Narration 🎤

Problem: Opera has dramatic stage directions

```
[The stage is lush and green, tangled with vines and enormous leaves.
Birds call from above, and shafts of golden sunlight pierce the green gloom.]
```

Solution: ElevenLabs + Java HttpClient

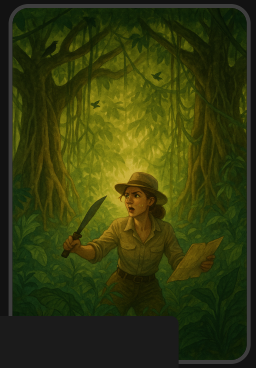
```java
private Path generateAudio(String text, String voiceId, Path outputPath) throws IOException {
    var request = HttpRequest.newBuilder()
        .uri(URI.create(API_URL + voiceId))
        .header("xi-api-key", ELEVEN_LABS_API_KEY)
        .header("Content-Type", "application/json")
        .POST(HttpRequest.BodyPublishers.ofString(jsonBody))
        .build();

    // Stream directly to file - no intermediate memory!
    var response = client.send(request, HttpResponse.BodyHandlers.ofFile(outputPath));

    return outputPath;
}

// And then play it live!
AudioPlayer.play(audioFile);
```

The AI Opera Critic 🎭



Problem: Every opera needs a critic's review

Solution: Gemini 2.5 Flash as Anton Ego

```
public class OperaCritic {
    private final ChatLanguageModel model = GoogleAiGeminiChatModel.builder()
        .apiKey(ApiKeys.GOOGLEAI_API_KEY)
        .modelName("gemini-2.0-flash-exp")
        .temperature(0.8)  // More creative for criticism
        .build();

    public void reviewAndSave(Path operaDir, String operaTitle) {
        String prompt = """
            You are a distinguished opera critic in the tradition of
            the great critics of the past. Review this AI-generated opera
            with wit, insight, and perhaps a touch of theatrical flair...
            """;
    }
}
```

AI Critic in Action 

Sample Review (Gemini 2.5 Flash on Hartford Ascending):

> *"Hartford Ascending is a triumph of absurdist opera, blending environmental catastrophe with mechanical madness in a way that only AI could conceive..."*

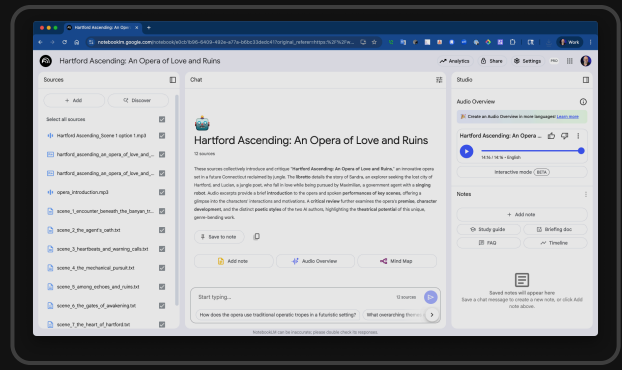
> *"The robot's multilingual arias are particularly memorable, though one wonders if Verdi is spinning in his grave..."*

> *"This fearless embrace of the bizarre creates something genuinely entertaining."*

Key Features:

- Understands opera conventions and traditions
- Provides both praise and constructive criticism
- Captures the theatrical voice of a seasoned critic
- Saves review as markdown alongside the opera

AI Podcast with NotebookLM 🎙️



Problem: Need expert analysis of our AI-generated opera

Solution: NotebookLM creates AI podcast hosts

- Upload **all opera files** (libretto, scenes, critique, images)
- NotebookLM **analyzes everything**
- Generates **14+ minute podcast** with two AI hosts
- Discusses themes, characters, artistic merits
- **"Two Guys Talking"** format about our opera

```
# What NotebookLM received:
- Complete 8-scene libretto
- Individual scene files
- Critical review
- Audio narration files
- Scene illustrations
```

Result: Professional analysis of Hartford Ascending! 🎭

Automated Formatting = Time Saved

Problem: Manual formatting of 500+ lines of opera

Solution: Format on save!

```
private static String formatSceneContent(String content) {
    // Detect character lines: "SANDRA (crying):"
    Matcher m = SINGING_PATTERN.matcher(line);
    if (m.matches()) {
        String character = m.group(1);
        String voiceType = determineVoiceType(character);

        // Auto-format with voice type
        result.append("**").append(character).append("** (")
              .append(voiceType).append("):\n");
    }

    // Convert lyrics to blockquotes
    if (inLyricSection) {
        result.append("> ").append(line).append("<br>\n");
    }
}
```

Live Demo! 🎭

Let's generate and play an opera together...

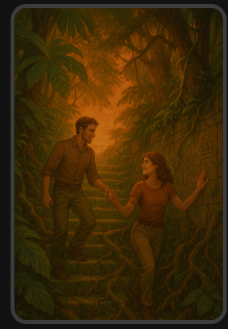
The Complete Workflow:

1. Generate scene with GPT-4.1/Claude Sonnet 4 ✅
2. Create illustration with gpt-image-1 ✅
3. Generate narrator audio with ElevenLabs ✅
4. **Play the audio live!** 🎵 ✅
5. **Plus: Suno AI opera music** 🎼 ✅

```
# Generate and play narrator in one command
./gradlew test --tests AudioDemoTest::generateAndPlayOperaIntroduction

# Then play actual opera music from Suno AI
# (Sandra and Lucian's duet from Scene 1)
```

The Complete AI Orchestra 🎼



Automated Pipeline (Java)

- GPT-4.1: Odd scenes ✅
- Claude Sonnet 4: Even scenes ✅
- gpt-image-1: All illustrations ✅
- ElevenLabs: Narrations ✅
- Gemini 2.5 Flash: Critique ✅

External Enrichment

- **Suno AI**: Opera music ✅
- **NotebookLM**: 14-min AI podcast ✅
- **Live Performance**: Java orchestration

Result: Complete multimedia opera experience! 🎭

🎵 **AI narrator** • 🎼 **Opera music** • 🎨 **Scene art** • 📖 **8-scene libretto**

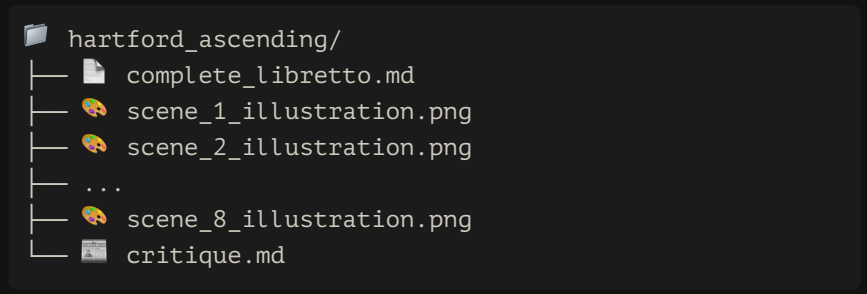
The Complete Opera

"Hartford Ascending"

- 8 Scenes
- 4 Character voices
- 2 AI authors alternating
- 1 Shared memory
- 0 Manual interventions

Total Generation Time: ~10 minutes

Manual Work Required: Zero!



Key Takeaways

1. **Multiple LLMs** create richer content through variety
2. **Shared Memory** maintains coherence across models
3. **Absurd Premises** + AI commitment = Comedy gold
4. **Modern Java** makes AI integration elegant
5. **Rate Limiting** prevents API throttling
6. **Automation** saves hours of manual work
7. **Test-Driven** approach works great for AI features
8. **AI Orchestra** approach multiplies creative possibilities
9. **Live Audio Demos** make presentations unforgettable
10. **Working end-to-end** beats theoretical examples every time

The AI Orchestra Pattern 

Each AI tool is like an instrument:

- **GPT-4.1/Claude Sonnet 4**: The composers (libretto)
- **gpt-image-1**: The set designer (visuals)
- **Suno**: The musicians (musical arias)
- **ElevenLabs + JLayer**: The narrator (stage directions + playback)
- **NotebookLM**: The podcast hosts (analysis)
- **Gemini 2.5 Flash**: The reviewer (critique)
- **Java**: The conductor (orchestration)

Key insight:

Don’t use one AI for everything.
Use the best AI for each specific task!

APIs & Technologies 🛠️

AI APIs Used (All Working!)

- **OpenAI**: GPT-4.1 & gpt-image-1 ✅
- **Anthropic**: Claude Sonnet 4 ✅
- **Google**: Gemini 2.5 Flash ✅
- **ElevenLabs**: Voice narration ✅
- **Suno AI**: Opera music ✅

Java Features Showcased

- **Virtual Threads** (JDK 21) ✅
- **Records & Pattern Matching** ✅
- **Text Blocks** ✅
- **HttpClient** (JDK 11+) ✅
- **JLayer** for Audio Playback ✅

Resources & Links 📚

Code & Documentation

- **GitHub**: github.com/kousen/OperaGenerator
- **LangChain4j**: docs.langchain4j.dev
- **Slidev**: sli.dev (for this presentation)

Hartford Ascending Assets

- **AI-Generated Podcast**: NotebookLM Discussion (14+ minutes)
- **Complete Libretto**: Available in the GitHub repository
- **Scene Illustrations**: All 8 AI-generated images included

Try It Yourself

- Clone the repository
- Set your API keys

Thank You! 🎭

Questions?

GitHub Issues for feature requests
Contributions welcome!
Let's discuss AI orchestration!

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